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EVALUATION OF A LEASED OYSTER BOTTOM IN MISSISSIPPI SOUND

JOHN SUPAN
Fisheries Research and Development Section,
Gulf Coast Research Laboratory, Ocean Springs, Mississippi 39564

ABSTRACT Twenty-four pairs of spat plates, strategically located on a 600-ha (1500-a) oyster lease, were monitored biweekly to determine the rate of oyster spatfall. Spatfall occurred from May 6 to July 31 and again from August 15 to October 24, 1979. The greatest spatfall occurred from August 15 to September 4, 1979. Data from shell bags that accompanied the spat plates indicated a maximum growth of 3.2 cm in two months. Oyster spat which attached to the planted cultch materials on the leases grew up to 7.9 cm during the 17-month sampling period, ending December 11, 1979. The lease area is capable of producing commercial-sized oysters in two seasons.

INTRODUCTION

During 1970, the Bureau of Marine Resources (formerly Mississippi Marine Conservation Commission) was granted statutory authority to lease water bottoms for the purpose of private oyster culture (49–15–27, Mississippi Code 1972, Chapter 15). Since then, techniques to improve the success of oyster culture on planted cultch have become a need of private lessees. Also, lending institutions need production and profit data before investing in mariculture endeavors. During 1979 and 1980, an Oyster Culture Demonstration Project, supported by the Mississippi Sea Grant Advisory Service, was conducted to document lease productivity. This manuscript is based on that project.

The purposes of the study were to determine: 1) the rate of oyster spatfall (no. m^{-2} day^{-1}); 2) the subsequent oyster growth on planted cultch material; and 3) the location of spat-preference areas on a private oyster lease.

The spat sampling material used in this study was similar to that used in previous experiments (Cole and Knight-Jones 1939, Butler 1955, Shaw 1967). Smooth, artificial materials, such as asbestos plates, cement board, and slate, have been used for quantification of spatfall, since determining spatset on irregularly shaped and textured shells is difficult. Such material is usually cut into squares of a particular size and deployed in pairs in the water. The plates can be made to approximately equal areas of the inner faces of oyster shells. Previous data revealed a close similarity of trends in setting on the two substrates (Shaw 1967). The under-surface of the plates especially attract the negatively phototaxic oyster larvae (Galtstoff 1964, Ritchie and Menzel 1969).

Fouling on newly planted cultch material is detrimental to spatset. Hoese et al. (1972) discovered that the barnacle (*Balanus eburneus* Gould) set on asbestos plates was 78 times that of oysters in Mobile Bay, Alabama. Encrusting bryozoans (i.e., *Membranipora* spp. and *Electra* spp.) can also cause serious fouling, thus delaying cultch planting until oyster setting is imminent (Beaven 1947). Another bryozoan (*Bowerbankia gracilis* Leidy) was found to secrete metabolites which were detrimental to oysters (MacKenzie 1970). McGraw (1980) also found that barnacles and colonial bryozoans compete with oyster larvae for setting space in Mississippi Sound.

Leases at Bellefontaine Point (Figure 1) may be excellent for oyster culture because of their proximity to Biloxi and Pascagoula bays, where large oyster reefs exist. Eleuterius (1976) reported that the core of the discharge from the West Pascagoula River follows the shoreline westward past Graveline Bayou, then southward (over the lease area), exiting the Sound through Dog Keys Pass. He also found that during certain times of the year, Biloxi Bay's outflow merges with water from the West Pascagoula River south of Bellefontaine Point. Because of the higher salinity of the central and eastern Mississippi Sound, few areas that appear suitable for oyster culture occur outside of existing natural oyster reefs; however, one area that should receive serious consideration is south of Bellefontaine Point (Eleuterius 1977).

MATERIALS AND METHODS

Spat sampling apparatuses consisted of two 10x10x0.6-cm asbestos plates held apart by a 0.6-cm piece of PVC pipe (1.25 cm diameter), suspended through the center with polypropylene rope (0.6-cm diameter) (Figure 2). A wire pin was used in one corner to prevent plate-to-plate rotation. One set of spat plates was positioned at each of 24 wooden pilings which marked the corners of 15 40-ha (100-a) leases (approximately 400 m south of Bellefontaine Point (Figure 2). The plates were anchored to pilings at the waterline and to a shell bag, resting on the bottom. Fortnightly monitoring of the plates occurred from April 16 through October 24, 1979. The plates were collected, rinsed with tap water and air dried. The plates (both sides) were examined with a 7X dissecting, stereomicroscope. Oyster spat were counted and recorded as the number of spat set per m^2 per day, using the formula:

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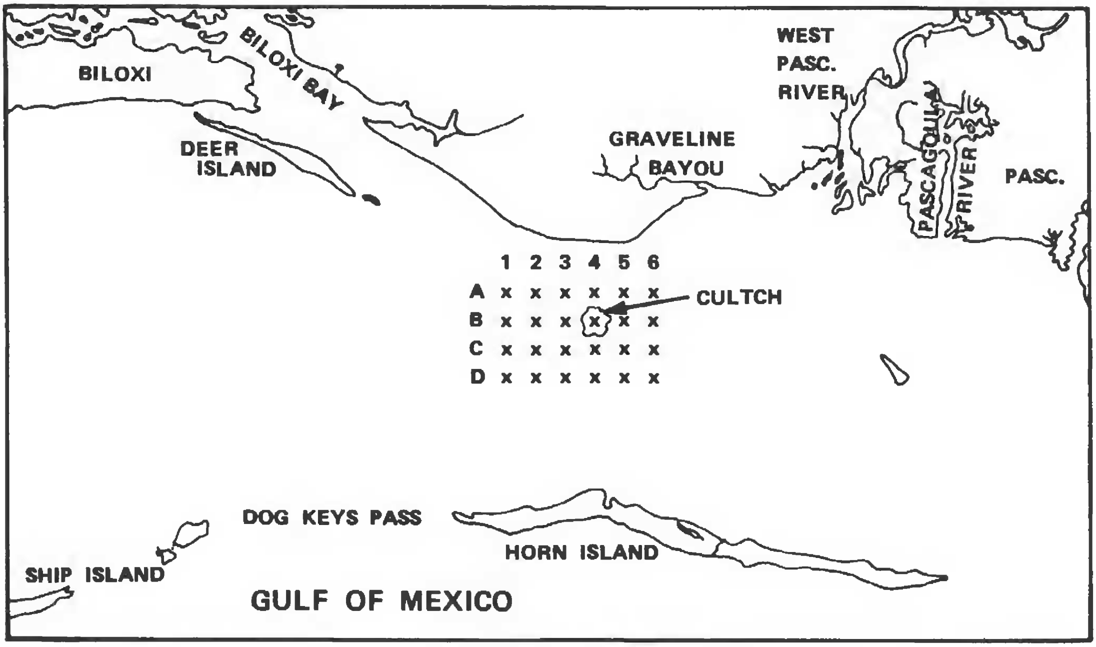

Figure 1. Map of lease area (x denotes corner piling).

$$\frac{\text{Total no. spat} \div \text{Total no. plate sides (100 cm}^2\text{/side)}}{\text{Total no. days exposed}} \times 100$$

Plates were scraped with a putty knife, cleaned with a wire brush and reused for subsequent collection periods.

The shell bags consisted of 1.9-cm (mesh size) Dupont Vexar® cylindrical webbing containing 0.015 m^3 (0.5 ft^3) of washed oyster shells. Fresh bags were placed on the leases from June 1 to July 31, 1979 and from July 31 to December 11, 1979, which coincided with spring and fall spawning periods, respectively. After collection, each bag was tagged, rinsed with tap water and air dried. Spat on individual oyster valves were counted with a 2X desk lens.

Bottom and surface water temperatures and salinities were determined during every sample collection. A hand-held mercury thermometer and a refractometer (Model AM 126, AO Instrument Company) were used.

The leaseholder (E. R. Gollott, Cap'n Gollott Seafood, Biloxi, Mississippi) planted approximately 2080 m^3 of cultch material (*Rangia* clam shells) on June 1, 1979. A 0.4-ha (1-a) plot was established over the planted shells using four corner poles placed 35.9 m (118 ft.) from a center pole in north, south, east, and west directions.

Oysters from the 0.4-ha plot were sampled on May 7 and November 11, 1980. Three 0.5-m^2 samples were collected along each of the north, south, east, and west transects from the center. The samples were analyzed for oyster data including: 1) total number alive; 2) size range; 3) mean size; 4) total number dead; and 5) percent mortality. Live oysters were measured and grouped in 1.0-cm categories ranging from 0.0–0.9 to 7.0–7.9 cm. All detached left valves and empty boxes were counted as dead oysters. Predators were also noted by species and prevalence.

RESULTS

Spatfall Analyses

Data indicated that spatfall occurred from approximately May 6 through July 31, and again from August 15 through October 24, 1979 (Table 1). I believe, however, that spatfall occurred beyond October, since small, live spat (0.8 cm) were found on cultch material collected on December 11, 1979. Smaller spat (0.2 cm) were also found on shell bag cultch collected the same day. The heaviest spatfall over the entire lease area occurred from August 15 to September 5, followed by a similar peak the following two weeks (Tables 1, 2, and 3). Peak spatfall for the spring spawning occurred from June 16 to July 31, 1979 (Tables 1 and 4). A two-way analyses of variance (Steel and Torrie 1980) revealed no statistically consistent north-south or east-west preference for spatfall over the lease area (Tables 2, 3, and 4). Data collected from August 15 to September 5, however, produced an F-value significantly higher than the 99th percentile, showing a possible north-south preference of spatfall for that time period (Table 2).

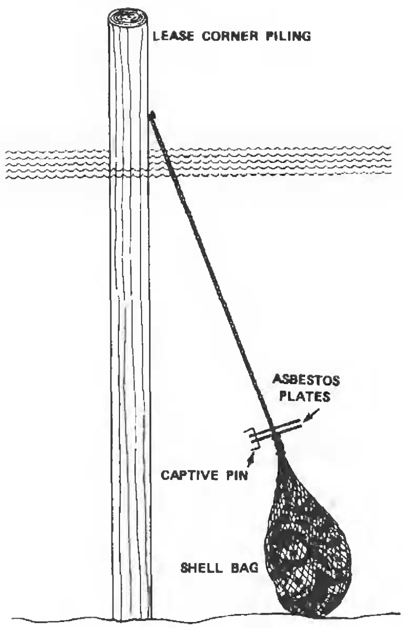

Figure 2. Spat plate-shellbag sampling apparatus.

Cultch Analyses

Cultch samples produced data verifying that good oyster growth is possible in a short period of time in Mississippi Sound. Data from shell bags showed growth of up to 3.2 cm in two months (June 1–July 31) and 4.2 cm in five months (July 31–December 11, 1979).

The first cultch sampling (May 7, 1980) from the 0.4-ha plot also indicated good oyster growth. The maximum oyster size was 5.2 cm (Table 5). The mean size was relatively the same from all four sampled areas, ranging from 1.82 to 2.29 cm. Samples from the eastern area produced the highest density (318/0.5 m^2) and the lowest mortality, with 56% of the live oysters falling in the 1.0- to 1.9-cm size category (Table 5). The mean oyster size from all of the 0.5-m^2 samples was 2.0 cm, with a mean density of approximately 139 oysters/0.5 m^2. The 1.0- to 1.9-cm size category produced the highest percentage of the total (51.6%). The mortality averaged 19.5%; however, most of the dead oysters were in the 0.0- to 0.9-cm size range.

The data from the second cultch sampling (November 11, 1980) from the 0.4-ha plot indicated another spatfall during that year along with an increase in the size range. The mean size from the four areas on the plot ranged from 2.3 to 2.9 cm (Table 6). The largest oyster was 7.7 cm. The spatfall that occurred during 1980 accounted for >17.9% of all oysters measured. The eastern area produced the highest density (318/0.5 m^2) and the lowest mortality (11.9%), with the 1.0- to 1.9-cm category contributing 56% of the total. For all areas, the mean oyster size was 2.0 cm, with a mean density of approximately 141.3/0.5 m^2. The 2.0- to 2.9-cm category produced the highest percentage of the total 51.6%.

TABLE 1.

Spat plate data from April 4 to October 24, 1979.

Dates	Total no. spat	Total no. plates used	Total no. spat per m^2 per day	(ppt) Bottom salinity range	(°C) Average bottom temperature
04 Apr-17 Apr	0	48	0.0	2–12	21.0
17 Apr-06 May	0	48	0.0	6–18	22.0
06 May-20 May	2	48	0.14	4–12	25.0
20 May-01 Jun	23	48	1.99	8–15	26.5
01 Jun-16 Jun	17	48	1.18	12–20	27.5
16 Jun-03 Jul	190	46	11.47	14–21	30.0
03 Jul-17 Jul	10	48	0.74	18–22	30.0
17 Jul-31 Jul	14	48	1.04	7–17	30.0
31 Jul-15 Aug	0	48	0.0	16–19	30.0
15 Aug-05 Sep	5196	46	268.94	19–22	—
05 Sep-24 Sep	4600	46	263.15	11–15	22.0
24 Sep-24 Oct	265	14	31.54	20–23	20.0

DISCUSSION

Spatfall Analyses

This study indicated no preference in spatfall settling within the lease area. Table 1 clearly shows, however, the occurrence of two spatfall periods (May 6 to July 31 and August 15 to October 24). The double-spawning of oysters along the Gulf has been known since it was discovered by Hopkins (1931) in Galveston Bay, Texas. He found spatfall to be dependent on temperature and salinity. Based on previous studies which found that 3 to 25 spat/shell constitute a commercial spatset (Lindsay et al. 1958, Quayle 1958), a spatfall of commercial intensity occurred during the study period.

Cultch Analyses

Obtaining a representative sample from an oyster reef using quadrate samples is difficult. Ogle (1980) reported that 40 replicate quadrate samples from the Biloxi Bay reef produced a fluctuating cumulative mean. The mean-to-variance ratio for the quadrate samples was greater than one (18.72) indicating a patchy oyster distribution and inadequate sample size. During this study, the mean number of oysters/0.5 m^2 quadrate sample was 176.2 oysters (Table 6), but the standard deviation was equal to half of the mean (±85.12). The high deviation indicates that more sampling is necessary; however, the value of the 0.4-ha reef can still be estimated. By extrapolation, the number of oysters on

TABLE 2.

Spatfall data from individual corner pilings during August 15 to September 5, 1979 (x denotes lost sample).

	1	2	3	4	5	6	Total	No. per m^2 per day
A	40	54	52	135	63	156	500	99.2
B	87	152	121	65	349	128	902	178.9
C	146	149	613	x	363	757	2028	482.8
D	141	51	345	486	518	225	1766	350.3
Total	414	406	1131	686	1293	1266		
No. per m^2 per day	123.2	120.8	336.6	272.2	384.8	376.7		

ANOVA = Analysis of Variance

North-South F = +6.733 (3.29 α = 0.05; 5.42 α = 0.01); East-West F = +2.112 (2.9 α = 0.05; 4.56 α = 0.01)

TABLE 3.

Spatfall data from individual corner pilings during September 5 to September 24, 1979 (x denotes lost sample).

	1	2	3	4	5	6	Total	No. per m^2 per day
A	24	327	815	534	383	214	2297	503.7
B	54	36	108	7	191	472	868	190.3
C	93	22	82	x	90	221	508	133.6
D	271	62	61	85	47	401	927	203.3
Total	442	447	1066	626	711	1308		
No. per m^2 per day	145.3	147.0	350.0	274.5	233.8	430.2		

North-South F = +2.963 (3.29 α = 0.05; 5.42 α = 0.01); East-West F = +0.897 (2.9 α = 0.05; 4.56 α = 0.01)

TABLE 4.

Spatfall data from individual corner pilings during June 16 to July 3, 1979 (x denotes lost sample).

	1	2	3	4	5	6	Total	No. per m^2 per day
A	5	6	19	3	8	15	56	13.7
B	12	20	14	x	6	6	58	17.0
C	6	5	11	1	19	9	51	12.5
D	6	7	4	2	2	4	25	6.1
Total	29	38	48	6	35	34		
No. per m^2 per day	10.6	13.9	17.6	2.9	12.8	12.5		

North-South F = +2.077 (3.29 α = 0.05; 5.42 α = 0.01); East-West F = +0.869 (2.9 α = 0.05; 4.5 α = 0.01)

the plot is 1,409,600±680,960. At 400 oysters/$10 bushel and commercial-sized oysters in two seasons, the 0.4-ha reef would be worth approximately $35,240±$17,024, barring high mortality. In fact, high mortality did occur on the reef during the summer of 1981, primarily because of predation by the southern oyster drill (*Thais haemastoma*).

Current lease production

Low production is characteristic of private leases in Mississippi waters. Currently, 772.8 ha (1908.24 a) are leased; however, less than 1% of the commercial oyster harvest is from private oyster leases (*fide*, Thomas VanDevender, Bureau of Marine Resources, Long Beach, Mississippi). The majority of production from these areas has been from the relaying of polluted oysters.

Lease productivity could be increased in a number of ways, all of which require intensive harvesting techniques. Once cultch material is planted, this initial investment is usually left unattended. The cultch, in the mean time, attracts crabs, fish, and commercial and recreational fishermen. By harvesting the commercial species attracted to the reef, an income from the initial investment could be immediately realized.

High oyster mortality is caused primarily by oyster drill predation. Recent shell plantings at the Round Island and Whitehouse areas by the Bureau of Marine Resources were

TABLE 5.

Pooled data from three 0.5-m^2 cultch samples collected from four, separate lease-plot areas, May 7, 1980.

Area	Total no. alive	Total no. alive within size categories (cm) 0.0–0.9	1.0–1.9	2.0–2.9	3.0–3.9	4.0–4.9	5.0–5.9	Size range (cm)	Mean size (cm)	Total no. dead	% Mortality
North	368	45	161	102	33	25	2	0.5–5.1	1.98	92	19.9
South	70	4	26	17	9	11	3	0.6–5.2	2.29	31	30.6
East	954	53	535	320	34	11	1	0.5–5.0	1.82	130	11.9
West	277	14	140	101	21	1	0	0.6–4.3	1.91	74	21.0
% of total		6.9%	51.6%	32.3%	5.8%	2.9%	0.5%				

TABLE 6.

Pooled data from three 0.5-m^2 cultch samples collected from four separate lease-plot areas November 11, 1980.

Area	Total no. alive	Total number alive within size categories 0.0–0.9	1.0–1.9	2.0–2.9	3.0–3.9	4.0–4.9	5.0–5.9	6.0–6.9	7.0–7.9	Size range	$\bar{X}$ size	No. dead	% Mortality
North	323	53	63	95	44	37	20	10	1	0.3–7.3	2.6	47	12.7
South	356	74	88	108	27	40	11	7	1	0.3–7.1	2.3	67	15.8
East	273	35	45	69	52	36	25	8	3	0.5–7.7	2.9	52	16.0
West	316	65	61	88	46	29	23	4	0	0.1–6.1	2.4	56	14.6
% of total		17.9%	20.3%	28.4%	13.3%	11.2%	6.2%	2.3%	0.4%				

decimated by drill infestation (*fide*, William Demoran, Gulf Coast Research Laboratory, Ocean Springs, Mississippi). Locating a lease near a freshwater source is generally used to combat this high-salinity predation; however, poor water quality caused by land runoff usually occurs. The only other alternative is to raise the oysters off the bottom, away from the drill predation, using lantern nets, Nestier® trays, Vexar® bags, or "chicken coops" (Supan 1981). The cost of this type of intensive culture could be defrayed by utilizing commercial species as previously mentioned.

In conclusion, present lease productivity in Mississippi Sound would not promote interest for financial backing by lending institutions, as hoped for by the Oyster Culture Demonstration Project. High spatfall and subsequent good oyster growth indicates a potential for high yields. A greater effort in farming a lease could produce a profit, provided the lessee utilized all of the available resources. In any event, oyster farming is considered a high risk investment.

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